Appendix B - SWMP Activity Data

MS4 Inventory Statistics

Household Chemical Collection Center

Inventory of Known Major Outfalls

Lab Analysis Sheets
Pesticide Data Analysis
Acid/Base Neutral Organic Analysis
Volatile Organic Analysis

City of Springfield, MO Biological Assessment of Urban Streams II Final Report

STORMWATER INVENTORY 6/30/06 — 68.5% Complete

POINT FEATURES

WATERSHED	Projected Point Features	6/30/06 Point Features	% Complete
FARMER BRANCH	64	61	95%
FASSNIGHT CREEK	894	838	94%
GALLOWAY CREEK	1005	975	97%
HUNT BRANCH	124	69	56%
INMAN CREEK	475	387	81%
JAMES RIVER	544	285	52%
JORDAN CREEK LOWER BRANCH	1283	1180	92%
JORDAN CREEK NORTH BRANCH	523	513	98%
JORDAN CREEK SOUTH BRANCH	1253	1040	83%
PEA RIDGE CREEK	599	227	38%
PIERSON CREEK	243	138	30%
RAINER BRANCH	464	76	16%
SOUTH CREEK	730	517	71%
SOUTH DRY SAC	852	102	12%
SPRING BRANCH	238	29	12%
THOMPSON BRANCH	130	119	92%
UPPER WILSONS CREEK	648	274	42%
WARD BRANCH	1375	1210	88%
WILSONS CREEK	398	157	39%
Total Features	**11842**	**8197**	

TOTAL % COMPLETE **69%**

LINEAR FEATURES

WATERSHED	Projected Linear Feet	6/30/06 Linear Feet	% Complete
FARMER BRANCH	8199.18	8035.2	98%
FASSNIGHT CREEK	202076	154370.06	76%
GALLOWAY CREEK	241432	230730.41	96%
HUNT BRANCH	9636	5703.83	59%
INMAN CREEK	107466	84355.42	78%
JAMES RIVER	122927	66450.22	54%
JORDAN CREEK LOWER BRANCH	189676.01	176398.69	93%
JORDAN CREEK NORTH BRANCH	179866.73	170873.39	95%
JORDAN CREEK SOUTH BRANCH	283389	193627.63	68%
PEA RIDGE CREEK	135512	51007.69	38%
PIERSON CREEK	54892	27182.15	50%
RAINER BRANCH	104969	9096.65	9%
SOUTH CREEK	165025	139341.79	84%
SOUTH DRY SAC	192722	59887.01	31%
SPRING BRANCH	53839	18309.59	34%
THOMPSON BRANCH	48377.49	45474.84	94%
UPPER WILSONS CREEK	146606	53283.24	36%
WARD BRANCH	260119	231749.86	89%
WILSONS CREEK	90046	50135.24	56%
Total Feet	**2596775.41**	**1776012.91**	
Total Miles	**492**	**336**	

TOTAL % COMPLETE **68%**

CITY of SPRINGFIELD

Household Chemical Collection Center

Twelve Year Totals

(Open August 14, 1994)

	05-06 Year Totals	12 year Totals	12 year Averages	
Appointments	2,477	**33,470**	**2,789**	ea. 5 gallon,1 box or 50 lbs
Lab Pack Materials				
***Destroyed in lbs.**	11,710	173,840	14,487	all pesticides,acids,bases. Non-recyclables roofing tar, driveway sealers, poisons
Latex Paint	28,600	329,545	27,462	
Oil Base Paint	10,296	151,532	12,628	
Fuels	4,420	46,547	3,879	gasoline, liquid waxes, car additives
Batteries	3,300	25,332	2,111	year 12 will have only rechargeable batteries
Fluorescent Tubes	30	795	66	
Tin	0	53,488	4,457	old paint cans/discontinued
Cardboard	3,500	38,268	3,189	customer boxes only
Car Batteries	2,870	43,199	3,600	
Oil Filters	0	296	25	if they have oil drained into waste oil then disposed of
Antifreeze	3,760	32,595	2,716	
Waste Oil	4,699	111,994	9,333	
Misc. Materials Ex.	5,538	61,946	5,162	paints, adhesives, etc. re-used locally
Total Pounds Recycled	**68,220**	**896,771**	**74,731**	
Total Destroyed of/Recycled	**79,930**	**1,070,611**	**89,218**	total waste collected
% Recycled	**85%**	**83%**	**84%**	

Avg. lbs. of material recycled per appointment	**26.79**
Avg. lbs. of material destroyed of per appointment	**5.19**
Ave. % Recycled in 12 years	**84%**
12 year total appointments	**33,470**
12 year total in pounds	**1,070,611**

*Materials destroyed are incinerated in a licensed, regulated hazardous waste facility

City Of Springfield
Public Works Department
Solid Waste Management Division
PO Box 8368
Springfield, MO. 65801
417-864-1905
Recycling Hotline: 417-864-1904
www.springfieldmogov.org/recycling

Printed on recycled paper

KNOWN MAJOR OUTFALLS INVENTORY*

FEATURE TYPE	ADDRESS	LANDUSE
	FASSNIGHT CREEK WATERSHED	
10' X 3.5' BOX CULVERT	1451 S THELMA AV	RESIDENTIAL & COMMERCIAL
54" RCP	MAPLE PARK CEMETARY	RESIDENTIAL & COMMERCIAL
5' X 3.5' BOX CULVERT	FASSNIGHT BOX BETWEEN HOLLAND & KIMBROUGH	RESIDENTIAL
12' X 4' BOX CULVERT	KINGS AND BROOKSIDE (UNDERNEATH KINGS INTO CREEK)	RESIDENTIAL
	GALLOWAY CREEK WATERSHED	
47" X 31" BOX CULVERT	4300 BLK S LONE PINE AVE AT RAGAN CT	RESIDENTIAL
2 @ 36" CMP	3500 BLK S LONE PINE AVE, E SIDE OF RR	RESIDENTIAL
2 @ 42" RCP	W SIDE 3200 BLK S INGRAM MILL RD	COMMERCIAL & RESIDENTIAL
48" RCP	SE CORNER BARATARIA ST & CHANTILLY AVE	RESIDENTIAL
36"RCP	SE CORNER LUSTER AVE & SUNSET ST	RESIDENTIAL
42" CMP	400' S OF 2500 BLK E SUNSHINE ST, W SIDE OF RR	INDUSTRIAL
2 @ 42" CPVC & RCP PIPES	1855 S INGRAM MILL RD	COMMERCIAL
60" RCP	1855 S INGRAM MILL RD	COMMERCIAL
8.5' X 3' BOX CULVERT	SW CORNER 2620 E SUNSHINE ST	RESIDENTIAL & COMMERCIAL
48" CMP	2900 BLK E EASTMOOR DR	COMMERCIAL
2 @ 38" X 60" HECP	3103 E TOPPING CIRCLE	RESIDENTIAL
42" RCP	SE CORNER GLENSTONE AVE & SUNSET ST	RESIDENTIAL & COMMERCIAL
21 X 4 BOX CULVERT	S SIDE SUNSET ST AT BRENTWOOD AVE	RESIDENTIAL
	INMAN CREEK WATERSHED	
3@ 24" x 38" HECP	426 E MONTCLAIR ST	COMMERCIAL, RESIDENTIAL (APTS)
	JORDAN CREEK WATERSHED	
CHANNEL	NE CORNER 1200 BLK W NICHOLS & RR	COMMERCIAL, RESIDENTIAL, INDUSTRIAL
48" RCP	SE CORNER KANSAS EXPY/WALNUT ST	COMMERCIAL & INDUSTRIAL
36" RCP	N SIDE 1900 BLOCK W GRAND	COMMERCIAL
7' X 4' BOX CULVERT	S SIDE 1900 BLOCK W GRAND	COMMERCIAL
5' x 2' BOX CULVERT	E SIDE 900 BLOCK N FRANKLIN	RESIDENTIAL
2@8' X 5' BOX CULVERT	SW CORNER NICHOLS/BROADWAY	RESIDENTIAL
2@12' X 4' BOX CULVERT	S SIDE OF CHESTNUT EXPY, E OF FRANKLIN	RESIDENTIAL, COMMERCIAL
2@6' x 4' BOX CULVERT	JORDAN CREEK WEST OF GRANT AVENUE VIADUCT	INDUSTRIAL, COMMERCIAL
2@6' X 3' BOX CULVERT	319 N MAIN AV (FROM S INTO CREEK UNDER BUILDING)	INDUSTRIAL, COMMERCIAL
48" RCP	JORDAN CREEK AT BENTON VIADUCT (FROM 2 INTO CREEK)	INDUSTRIAL, COMMERCIAL
3.5' X 5.5' BOX CULVERT	JORDAN CREEK AT JEFFERSON AV (FROM S INTO CREEK)	INDUSTRIAL, COMMERCIAL
9' X 4' BOX CULVERT	JORDAN CREEK AT MAIN AV (FROM N UNDER MAIN)	INDUSTRIAL, COMMERCIAL
	JORDAN CREEK NORTH BRANCH WATERSHED	
36" RCP	NE CORNER CLAY/CENTRAL	COMMERCIAL, RESIDENTIAL
4.5' X 3' BOX CULVERT	JORDAN NB UNDER PROSPECT AV	RESIDENTIAL, COMMERCIAL
4' X 3.5' BOX CULVERT	JORDAN NB UNDER FREMONT AV	RESIDENTIAL, COMMERCIAL
43" X 27" CMP	S OF BLAINE AT NIAS	INDUSTRIAL, COMMERCIAL
6' X 2' BOX CULVERT	BLAINE/YATES (FROM N INTO CREEK)	RESIDENTIAL
	JORDAN CREEK SOUTH BRANCH WATERSHED	
42" RCP	JORDAN SB WEST OF NATIONAL AV (FROM N INTO CREEK)	COMMERCIAL
36" RCP	JORDAN SB UNDER NATIONAL AV (FROM N INTO CREEK)	COMMERCIAL
42" RCP	JORDAN SB UNDER NATIONAL AV (FROM S INTO CREEK)	COMMERCIAL
4' x 4' BOX CULVERT	N OF 1500 BLOCK W TRAFFICWAY(FROM S TO RR CHANNEL)	COMMERCIAL
4' X 6' BOX CULVERT	1630 E CHESTNUT EXPY	COMMERCIAL
3.5' X 3' BOX CULVERT	JORDAN SB UNDER GLENSTONE VIADUCT	COMMERCIAL
	PEA RIDGE CREEK WATERSHED	

6' x 4' BOX CULVERT	600 BLOCK E TURNER ST	RESIDENTIAL
2' X 2' BOX CULVERT	2244 N BOLIVAR RD	RESIDENTIAL, COMMERCIAL
6' X 4.5' BOX CULVERT	2244 N BOLIVAR RD	RESIDENTIAL, COMMERCIAL
5' X 3' BOX CULVERT	2244 N BOLIVAR RD	RESIDENTIAL
WARD BRANCH WATERSHED		
38" X 60" HECP	1062 E PENDLETON PL	RESIDENTIAL
2 @ 7' X 3' BOX CULVERT	1200 BLK E BRADFORD PKWY	COMMERCIAL
42" RCP	1465 E PRIMROSE ST	COMMERCIAL
60" RCP	1465 E PRIMROSE ST	RESIDENTIAL
2 @ 30" RCP	E SIDE 1630 E BRADFORD PKWY	COMMERCIAL
42" RCP	3700 BLK S WELLER	COMMERCIAL
36" RCP	3801 S NATIONAL AVE	COMMERCIAL
72" RCP	SW CORNER 3801 S NATIONAL AVE	COMMERCIAL
2 @ 72" RCP	1035 E REPUBLIC RD	COMMERCIAL
36" RCP	4109 S NATIONAL AVE	COMMERCIAL
WILSONS CREEK WATERSHED		
6' x 2.5' BOX CULVERT	1100 BLOCK S HILLCREST (FROM N INTO E-W CHANNEL)	RESIDENTIAL

*Major outfalls are identified as mapping of the MS4 progresses.

SOUTHWEST WASTEWATER PLANT LABORATORY
SPRINGFIELD, MISSOURI
PESTICIDE DATA ANALYSIS

SAMPLE NUMBER:
SAMPLE NAME:

SAMPLE DATE: See 2002-2003, 2003-2004, 2004-2005, and 2005-2006 sample dates
SAMPLE TYPE: GRAB
SAMPLE CODE: SE
SUBMITTED BY:

ORGANIC COMMENTS:

PESTICIDE EPA METHOD: 624
PESTICIDE CONC UNITS: UG/L

COMPOUND		COMPOUND	
ALDRIN	<0.005	ENDRIN	<0.005
ALPHA-BHC	<0.005	ENDRIN ALDEHYDE	<0.005
BETA-BHC	<0.005	HEPTACHLOR	<0.005
GAMMA-BHC (LINDANE)	<0.005	HEPTACHLOR EPOXIDE	<0.005
DELTA-BHC	<0.005	PCB-1242	<20
CHLORDANE	<0.010	PCB-1254	<20
4,4-DDT	<0.005	PCB-1221	<10
4,4-DDE	<0.005	PCB-1232	<10
4,4-DDD	<0.005	PCB-1248	<20
DIELDRIN	<0.005	PCB-1260	<20
ALPHA-ENDOSULFAN	<0.005	PCB-1016	<20
BETA-ENDOSULFAN	<0.005	TOXAPHENE	<0.025
ENDOSULFAN SULFATE	<0.005		

NR = NOT RUN

SOUTHWEST WASTEWATER PLANT LABORATORY
SPRINGFIELD, MISSOURI
ACID/BASE NEUTRAL ORGANIC ANALYSIS

SAMPLE NUMBER
SAMPLE NAME:
SAMPLE DATE: See 2002-2003, 2003-2004, 2004-2005, and 2005-2006 sample dates
SAMPLE TYPE: GRAB
SAMPLE CODE: SE
SUBMITTED BY:

ORGANIC COMMENTS:

B/NEPA METHOD 625 **B/NCONC UNITS** UG/L **ACIDS EPA METHOD** 625 **ACIDS CONC UNITS** UG/L

BASE NEUTRAL ORGANIC COMPOUNDS

N-NITROSODIMETHYLAMINE	<l0
BIS(2-CHLOROETHYL) ETHER	<10
1.3-DICHLOROBENZENE	<l0
1.4-DICHLOROBENZENE (BN)	<10
1,2-DICHLOROBENZENE (BN)	<10
BIS 2-CHLOROISOPROPYLE ETHER	<10
HEXACHLOROETHANE	<10
N-NITROSODI-N-PROPYLAMINE	<10
NITROBENZENE	<10
ISOPHORONE	<10
BIS 2-CHLOROETHOXY METHANE	<10
1,2,4-TRICHLOROBENZENE	<10
NAPHTHALENE	<10
HEXACHLOROBUTADIENE	<10
HEXACHLOROCYCLOPENTADIENE	<10
2-CHLORONAPHTHALENE	<10
DIMETHYLPHTHALATE	<10
ACENAPHTHYLENE	<10
2,6-DINITROTOLUENE	<10
ACENAPHTHENE	<10
2,4-DINITROTOLUENE	<10
DIETHYLPHTHALATE	<l0
FLUORENE	<l0
4-CHLOROPHENYL PHENYL ETHER	<10
N-NITROSODIPHENYLAMINE	<10
1,2-DIPHENYLHYDRAZINE	<10
4-BROMOPHENYL PHENYL ETHER	<l0
HEXACHLOROBENZENE	<10
PHENANTHRENE	<10
ANTHRACENE	<10

BASE NEUTRAL ORGANIC COMPOUNDS

DI-N-BUTYLPHTHALATE	<l0
FLUORANTHENE	<10
BENZIDINE	<10
PYRENE	<l0
BUTYLBENZYLPHTHALATE	<10
BENZO(A) ANTHRACENE	<l0
3,3-DICHLOROBENZIDINE	<l0
CHRYSENE	<10
B1S(2-ETHYLHEXYL) PHTHALATE	<10
DI-N-OXTYLPHTHALATE	<l0
BENZO(B) FLUORANTHENE	<10
BENZO(K) FLUORANTHENE	<l0
BENZO(A) PYRENE	<10
INDENO(1,2,3-C,D) PYRENE	< 10
DIBENZO(A,H) ANTHRACENE	<10
BENZO(B,H,I) PERYLENE	<10
2,3,7,8 TCDD (DIOXIN)	< 10
BROMOMETHOXYNAPHTHALENE	<10

ACID ORGANIC COMPOUNDS

PHENOL	<10
2-CHLOROPHENOL	<10
2-NITROPHENOL	<20
2,4-DIMETHYLPHENOL	<10
2,4-DICHLOROPHENOL	<l0
P-CHLORO-M-CRESOL	<10
2,4,6-TRICHLOROPHENOL	<10
2,4-DINITROPHENOL	<25
4,6-DINITRO-O-CRESOL	<25
PENTACHLOROPHENOL	<25
4-NITROPHENOL	<25

nR = NOT RUN

SOUTHWEST WASTEWATER PLANT LABORATORY
SPRINGFIELD, MISSOURI
VOLATILE ORGANIC ANALYSIS

SAMPLE NUMBER:
SAMPLE NAME:
SAMPLE DATE:See 2002-2003, 2003-2004, 2004-2005, and 2005-2006 sample dates
SAMPLE TYPE: GRAB
SAMPLE CODE: SE
SUBMITTED BY:

ORGANIC COMMENTS:

VOLATILE EPA METHOD: 624
VOLATILE CONC UNITS: UG/L

COMPOUND		COMPOUND	
CHLOROMETHANE:	<10	TRANS 1,3-DICHLOROPROPENE:	<1
VINYL CHLORIDE:	<10	TRICHLOROETHYLENE:	<1
CHLOROETHANE:	<10	BENZENE:	<5
BROMOMETHANE:	<10	CIS 1,3-DICHLOROPROPENE:	<1
ACROLEIN:	<12	1,1,2-TRICHLOROETHANE:	<1
ACRYLONITRILE:	<22	DIBROMOCHLOROMETHANE:	<1
METHYLENE CHLORIDE:	<5	BROMOFORM:	<1
TRICHLOROFLUOROMETHANE:	<10	1,1,2,2-TETRACHLOROETHYLENE:	<1
1,1-DICHLOROETHYLENE:	<1	1,1,2,2-TETRACHLOROETHANE:	<1
1.1-DICHLOROETHANE:	<1	TOLUENE:	<5
TRANS1.2-DICHLOROETHYLENE:	<1	CHLOROBEN2ENE:	<5
CHLOROFORM:	<1	ETHYLBENZENE:	<5
1.2-DICHLOROETHANE:	<1	2-CHLOROETHYL VINYL ETHER:	<10
1,1,1-TRICHLOROETHANE:	<1	DICHLORODIFLUOROMETHANE:	<10
CARBON TETRACHLORIDE:	<1	BIS(CHLOROMETHYL) ETHER:	<10
BROMODICHLOROMETHANE:	<1	XYLENE:	<10
1,2-DICHLOROPROPANE:	<1		

NR = NOT RUN

City of Springfield, Missouri

Biological Assessment of Urban Streams II

Final Report

July 2005 – June 2006

Prepared by:

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Missouri State University

Springfield, Missouri

Abstract

This study assessed the health of biotic communities in Jordan, Wilsons and Galloway Creeks, Springfield, Missouri. Fish and benthic macroinvertebrates were collected from each stream using the U.S. Environmental Protection Agency's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (RBP). Benthic macroinvertebrate metrics included the EPT Index, Taxa Richness (TA), Biotic Index (BI), and Shannon Diversity Index (SDI). The numbers of fish taxa present were evaluated with regionally modified metrics to extrapolate an Index of Biotic Integrity (IBI). A Physical Habitat Analysis was completed to provide a description of bottom composition, structure, and habitat. Sampling was carried out in fall of 2005 and spring of 2006. Stable, but impacted, communities of fishes were present in all streams; IBI results classified Jordan and Wilsons Creeks as moderately impaired and Galloway Creek as minimally impaired. Benthic macroinvertebrate communities were impaired in all three streams, with Jordan and Wilsons Creeks more impaired than Galloway Creek. Physical habitat analysis indicated relatively low percentages of riffle habitat in Jordan and Wilsons Creeks, and relatively high percentages of silt and sand substrate in Wilsons Creek.

Introduction

Urban streams in Springfield, Missouri are exposed to a number of stressors that impact the health of the organisms living in them. With growth and urbanization of the city of Springfield, the amount of impervious surfaces, such as roads, parking lots, and rooftops, has increased. These changes increase runoff volume and rate into the streams, increasing the physical disturbances from rain events. The streams also potentially receive more organic and inorganic pollutants from point and non-point sources than from a stream in a rural area. Still, many organisms in Galloway, Jordan, and Wilsons Creeks survive and flourish despite the anthropomorphic stressors on their environment.

The organisms that live in a stream can provide us with information about the health of the stream; biological communities reflect overall ecological integrity. Monitoring changes in the biological community can provide a broad measure of impact that integrates stresses over time (Barbour et al. 1999). One tool used to explain and quantify the health of a stream, as indicated by the biota collected, is the Index of Biotic Integrity (IBI). The IBI is based on categories or metrics, and can be adapted for different eco-regions. Metrics reflect aspects of the community such as diversity, sensitive species richness, and percent tolerant individuals. The metrics provide a score similar to a report card; the score signifies the level of impairment in comparison to a reference condition. For this study, the fish and benthic macroinvertebrate communities were sampled to evaluate ecological integrity with established, regionally-modified IBIs.

Electrofishing to obtain fish IBI data

Methods

The sample sites were selected by the City of Springfield and modified to reduce the impacts of bridge crossings (Keener 2003). The Jordan Creek sample site was located above (just north of) the Bennett St. crossing. The Wilsons Creek site was located above (just east of) the Scenic Ave. crossing, and the Galloway Creek site was located above (just north of) the James River Freeway crossing. The downstream end of each site started at least 100 meters upstream of the bridges. The length of the sample reach is determined as 20 times the average stream width, with a minimum of 150m and a maximum of 300 m. The same site reach was used for the fish, macroinvertebrate, and physical habitat assessments.

Fish Sampling

Fish were collected according to the protocol that the Missouri Department of Conservation (MDC) developed for the statewide bioassessment initiative (modified from their Rapid Bioassessment Protocols (RBP)). Galloway Creek was sampled on October 4, 2005 and April 7, 2006. Jordan Creek was sampled on October 6, 2005 and May 12, 2006. Wilsons Creek was sampled on October 13, 2005 and April 12, 2006. The sampling was conducted by isolating the sample reach with block nets and thoroughly electrofishing the entire reach using two Smith-Root backpack units. A team of four to six individuals started at the downstream end of the site and worked upstream. Every fish captured over two centimeters total length was identified and counted streamside and released. Specimens for each species sampled were collected and retained as voucher specimens.

Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates were sampled according to the RBP for multi-habitats. Ten samples were collected on each site. The amount of each habitat sampled was in approximate proportion to their representation; e.g., if there was 40% riffle then four samples were taken in random points in the riffle area. The collection was taken with a D-frame dip net. Lotic samples were taken with the net in a

fixed position and a square meter upstream of the net disturbed 10 centimeters deep where possible. Lentic samples were taken by disturbing a meter squared circle with the net following the feet of the disturber.

Galloway Creek was sampled on September 9, 2005 and February 13, 2006. Jordan and Wilsons Creeks were sampled on September 29, 2005 and March 17, 2006. In the lab, macroinvertebrates were separated from the organic matter and identified. All Ephemeroptera, Odonata, Trichoptera, and Coleoptera were identified to genus level, and other organisms such as Oligocheats, Hirundina, and Chironomids were identified to the lowest possible level. The specimens were preserved with 70% ethanol, labeled, and archived.

The primary metrics used to evaluate the benthic macroinvertebrate community were the Ephemeroptera/Plecoptera/Trichoptera (EPT) Index, Taxa Richness (TR), Biotic Index (BI), and Shannon Diversity Index (SDI). These metrics are suggested by the Missouri Department of Natural Resources (MDNR) protocol titled *Semi-Quantitative Macroinvertebrate Stream Bioassessment*. The EPT index is the number of genera belonging to the EPT orders, or more simply, the genera of mayflies, stoneflies, and caddisflies present in each sample. TR is the number of individual taxa represented and should increase with improving water quality. The BI is a regionally modified Hilsenhoff Biotic Index, where each taxon has an assigned tolerance value. The higher a BI score, the more tolerant/less healthy the community is. Finally, the SDI is a measure of community composition that takes into accounts both richness and evenness. "It is assumed that a more diverse community is a more healthy community; diversity increases as the number of taxa increase, and as the distribution of individuals among those taxa is more evenly distributed" (Sarver 2001).

These four metrics are used to calculate an index of biotic integrity called the Stream Condition Index (SCI). The SCI is calculated by MDNR for the spring and fall of each year from several reference streams. The metric scores in this study were compared to MDNR's reference scores from this ecoregion (warm water Ozark White River drainage). The result is a single percentage: if the study

stream scores 100%-80% of the reference biological criteria it is considered supporting; 70%-50% is considered partially supporting; and 40%-20% is considered non-supporting (Sarver 2001). It is important to note that since the EPA protocol was used in sampling macroinvertebrates in this study, not the MDNR protocol, the data collected may not be directly comparable to the regional reference data.

Physical Habitat Assessment

Physical habitat assessments were made using a modification of Missouri Department of Conservation protocol for the Channel/Riparian Cross-Section & Thalweg Profile. Assessments were made in Galloway and Wilsons Creeks in the spring of 2006. Spring assessments were not available for Jordan Creek; therefore, Fall 2006 assessments are reported. Each site was divided into ten equal units by placing 11 cross-sectional transects at equal intervals along the sampling reach length. Each transect was measured using four categories: substrate measurements, bank measurements, fish cover, and thalweg profile. For substrate, depth and substrate size were recorded at five stream cross-sections. Bank measurements included bankfull and wetted width, and bankfull and incised height. The fish cover category uses a qualitative estimate for the presence of various physical structures. Each sub-category was given a score of 0-4, according to the following criteria: 0 = absent, 1 = sparse (0-10%), 2 = moderate (10-40%), 3 = heavy (40-75%), 4 = very heavy (> 75%). Structure in this category included filamentous algae, macrophytes, large woody debris, brush, overhanging vegetation, undercut banks, boulders, and artificial structures. To obtain the thalweg profile, the thalweg depth was measured in ten equal spots along the transect (thalweg refers to a line drawn to join the lowest points along the length of the streambed).

Jordan Creek north of Bennett Street Bridge 4-21-2006 (l), and 4-29-2006 (r) following 2-inch rainfall

Results and Discussion

Fish Collections

The numbers of individual fishes collected from each site are listed by species in Tables 1-3. The diversity of fishes collected indicates that the streams are capable of supporting sustained fish populations. The presence of darters in Galloway Creek suggests healthy stream conditions; these small bottom species require unsilted gravel riffles for successful reproduction. Other species that are characteristic of healthy Ozark streams include the duskystripe or striped shiner, found in Galloway Creek and Wilsons Creek, and the longear sunfish, found in Galloway Creek.

The greater number of total individuals collected from Jordan and Wilsons Creeks doesn't necessarily reflect healthier populations than in Galloway Creek, especially since a significant portion are stonerollers, a tolerant minnow species. The large numbers of green sunfish in all locations may indicate impairment; this species is a predatory sunfish that tends to outcompete other sunfish species under impaired conditions. Other species that do well in impacted streams, especially those with high levels of sedimentation, are the mosquitofish and blackspotted topminnow. The common carp, collected in Wilsons Creek is an introduced exotic that commonly colonizes impaired stream habitats. The relative impairment of each stream is further quantified by the Index of Biotic Integrity (IBI) calculations.

The scores for each of the 12 metrics and an overall IBI for each sample are listed in Tables 4 and 5. Note that the maximum value for each of these metrics is 10 and that the overall IBI Score is the average of the individual metrics. Higher scores indicate greater biotic integrity and stream health.

Galloway Creek scored higher than Jordan and Wilsons Creeks in both fall and spring samples (Tables 4 and 5). The increase in the IBI from 78 to 85% from fall to spring in Galloway Creek is due to the increased number of species collected and the presence of orangethroat darters in the spring collection. It is unlikely that these differences are due to a change in stream health, but are possibly due to seasonal sampling variability (e.g. darters congregate in riffles during spring spawning runs). IBI values for Jordan and Wilsons Creek remained relatively stable from fall to spring. The IBI scores for all samples, except spring Galloway Creek samples, fall into what is classified as *moderately impaired*. The score of 85.3% for the spring Galloway Creek sample falls in the *minimally impaired* category (80-100 = minimally impaired, 60-80 = moderately impaired, below 60 = severely impaired).

A moderately impaired classification typically indicates that most sensitive fishes are absent and that the trophic structure is highly skewed towards omnivores, herbivores, and tolerant species. The lowest metric scores for Jordan and Wilsons Creeks were sensitive species richness and percent invertivores. Species classified as sensitive included the striped shiner and longear sunfish. Invertivores included the duskystripe shiner, blackspotted topminnow, longear sunfish, orangethroat darter, and logperch. The last 3 listed in this group were only found in Galloway Creek samples. Low values for this metric reflect the low diversity of benthic macroinvertebrate taxa (discussed below).

Comparisons with last year's (2004-05) collections from Jordan and Galloway Creeks indicate a slight decrease in IBI values for Jordan Creek (from 66.6 to 63.3 in fall, and from 66.3 to 65.3 in spring) and a slight increase in IBI values for Galloway Creek (from 76.8 to 78.0 in fall and from 80.1 to 85.3 in spring). It is unlikely that these are biologically meaningful changes; they most likely reflect sampling or annual variability. IBI values for each collection fell into the same impairment categories as in the previous year.

Specimens of longear sunfish and southern redbelly dace, two sensitive species, captured in Galloway Creek and Jordan Creek, respectively

Specimens of goldfish and common carp, introduced, tolerant species captured in Wilsons Creek

Specimens of yellow bullhead and green sunfish, tolerant species captured in Wilsons and Jordan Creeks, respectively

Benthic Macroinvertebrates

Each site yielded several taxa of benthic macroinvertebrates. The taxa collected and the numbers of individuals in each taxon are presented in Tables 6 – 11. The order Plecoptera (stoneflies) did not appear in any sample; this is notable because stoneflies are a relatively pollution intolerant group.

Total numbers of benthic macroinvertebrates collected ranged from 118 to 990. Galloway Creek samples had the greatest number of taxa (17 in both fall and spring) and individuals (731 in fall and 990 in spring). The low number of taxa in Jordan Creek (7 taxa, 82% chironomids) and Wilsons Creek (7 taxa, 66% chironomids) in spring could be the result of scouring due to flooding, resulting in the removal of much of the detritus in which most of the invertebrates live.

Table 12 presents a summary of the primary metrics for the macroinvertebrate community. Note the low values for Taxa Richness, EPT, and the Shannon Diversity Index for Jordan and Wilsons Creek in spring. Note the high EPT Index of 7 for Galloway Creek in spring. Table 13 shows how each sample scored with the Stream Condition Index (SCI). The SCI scores indicate that all three streams are "non-supporting". Again the lowest values were obtained for Jordan and Wilsons Creeks in spring.

Comparisons with last year's collections indicated a decrease from 2004-05 to 2005-06 in Taxa Richness for both Galloway Creek (from 22 to 14 in fall and from 19 to 17 in spring) and Jordan Creek (from 18 to 11 in fall and from 15 to 7 in spring), and in EPT Index for Galloway Creek (from 7 to 3 in fall and staying at 7 in spring) and Jordan Creek (from 4 to 3 in fall and from 3 to 2 in spring). Galloway Creek changed from "partially supporting" in spring 2006 to "non-supporting" in fall 2006-spring 2007. Reasons for these changes and whether they are biologically meaningful is unknown and will take additional years of sampling.

Portions of the sample site at Galloway Creek

Physical Habitat

Table 14 presents a summary of the physical habitat data for each stream. The stream reach was divided into 10 units using 11 equally spaced transects (identified as A-K); data were collected along a cross-section of the stream at each of these transects. The data reported in Table 14 consists of the mean values of measures taken or percentages of occurrences at each of these transects. Thalweg depth is measured as the water depth at the deepest point at each transect.

The relative sizes of the streams are reflected by the wetted widths, streams depths, and thalweg depths. Size increases from Galloway to Jordan to Wilsons. Notice the low percentages of silt-sand and vegetation and high percentages of undercut banks and bedrock in Jordan Creek. This may be a reflection of the channelized nature of this stream as it flows through Springfield, thus making it more prone to flash flooding and scour. These conditions are reflected in the low values for macroinvertebrate Taxa Richness, EPT Index, and Macroinvertebrate Stream Condition Index in Jordan Creek in Spring 2006.

Portions of the sample site at Jordan Creek (top) and Wilsons Creek (bottom)

Several other factors can be identified from Table 14 that could partially explain the values observed for fish and invertebrate metrics. The low percentage of riffles in Jordan and Wilsons Creeks (7 and 4 percent) could explain the lower metrics in those streams as compared to Galloway Creek (22 percent riffles). Riffles serve as desirable or necessary habitat for many invertebrate and fish species. For example the absence of darters in Jordan and Wilsons creek could reflect a lack of riffle spawning sights. The low percentages of preferred cover types, macrophytes, woody debris, brush, and boulders, could explain the general lack of sensitive predators, such as smallmouth bass and Ozark bass, in these streams, especially Jordan and Wilsons Creeks (Gunter 2002, Parnell 2005).

Dace spawning site at Jordan Creek (left); accumulation of debris at Galloway Creek (right)

Conclusions

Both fish and macroinvertebrate communities in these streams lack sensitive species that unimpacted streams of similar size in the area would probably contain. This may be due to the long period of urbanization in these watersheds. However, these streams do support a community of macroinvertebrates and fish that have remained fairly stable from fall 2004 through spring 2006. The relatively low level of impact on Galloway Creek is reflected in its healthier biological community. The same protocol as presented in this report will be followed in the 2006-07 year, providing continued monitoring of these urban streams.

Works Cited

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Table 1. Fishes Collected from Galloway Creek

Galloway Creek		**10/4/2005**	**4/7/2006**
Common Name	**Species**	**Individuals**	**individuals**
MINNOWS	**CYPRINIDAE**		
Stoneroller	*Campostoma spp.*	3	39
Striped Shiner	*Luxilus chrysocephalus*	0	6
Duskystripe Shiner	*Luxilus pilsbryi*	1	1
Creek Chub	*Semotilus atromaculatus*	0	1
CATFISHES	***ICTALURIDAE***		
Yellow Bullhead	*Ameiurus natalis*	5	2
KILLIFISHES	**FUNDULIDAE**		
Blackspotted Topminnow	*Fundulus olivaceous*	4	3
LIVEBEARERS	***POECILIIDAE***		
Mosquitofish	*Gambusia affinis*	0	2
SUNFISHES	**CENTRARCHIDAE**		
Bluegill	*Lepomis macrochirus*	16	130
Longear Sunfish	*Lepomis megalotis*	34	71
Green Sunfish	*Lepomis cyanellus*	36	32
Largemouth Bass	*Micropterus salmoides*	10	11
DARTERS	**PERCIDAE**		
Logperch	*Percina caprodes*	2	4
Orangethroat Darter	*Etheostoma spectabile*	0	45
	Total Individuals	**111**	**347**

Table 2. Fishes Collected from Jordan Creek

Jordan Creek		**10/26/2005**	**5/12/2006**
Common Name	**Species**	**Individuals**	**Individuals**
MINNOWS	**CYPRINIDAE**		
Stoneroller	*Campostoma spp.*	283	200
Duskystripe Shiner	*Luxilus pilsbryi*	4	0
Southern Redbelly Dace	*Phoxinus erythrogaster*	135	190
Creek Chub	*Semotilus atromaculatus*	52	65
Bluntnose Minnow	*Pimphales notatus*	0	5
SUCKERS	**CATOSTOMIDAE**		
White Sucker	*Catostomus commersoni*	14	35
CATFISHES	***ICTALURIDAE***		
Yellow Bullhead	*Ameiurus natalis*	5	8
KILLIFISHES	**FUNDULIDAE**		
Blackspotted Topminnow	*Fundulus olivaceous*	20	23
LIVEBEARERS	***POECILIIDAE***		
Mosquitofish	*Gambusia affinis*	45	11
SUNFISHES	**CENTRARCHIDAE**		
Bluegill	*Lepomis macrochirus*	4	2
Green Sunfish	*Lepomis cyanellus*	31	54
Hybrid Sunfish		0	1
	Total Individuals	**593**	**594**

Table 3. Fishes Collected from Wilsons Creek

Wilsons Creek		**10/13/2005**	**4/21/2006**
Common Name	**Species**	**Individuals**	**Individuals**
MINNOWS	**CYPRINIDAE**		
Stoneroller	*Campostoma spp.*	296	195
Duskystripe Shiner	*Luxilus pilsbryi*	27	23
Southern Redbelly Dace	*Phoxinus erythrogaster*	102	218
Creek Chub	*Semotilus atromaculatus*	46	82
Goldfish	*Carassius auratus*	1	0
Common Carp	*Cyprinus carpio*	11	4
SUCKERS	**CATOSTOMIDAE**		
Golden Redhorse	*Moxostoma erythrurum*	0	16
CATFISHES	***ICTALURIDAE***		
Yellow Bullhead	*Ameiurus natalis*	7	17
KILLIFISHES	**FUNDULIDAE**		
Blackspotted Topminnow	*Fundulus olivaceous*	56	10
LIVEBEARERS	***POECILIIDAE***		
Mosquitofish	*Gambusia affinis*	48	13
SCULPINS	**COTTIDAE**		
Banded Sculpin	*Cottus carolinae*	0	2
SUNFISHES	**CENTRARCHIDAE**		
Bluegill	*Lepomis macrochirus*	4	3
Green Sunfish	*Lepomis cyanellus*	41	21
Largemouth Bass	*Micropterus salmoides*	0	1
	Total Individuals	**639**	**605**

Table 4. Fish Index of Biotic Integrity (IBI) Scores from Fall 2005

Fall 2005 IBI Metrics			
Metric	**Galloway**	**Jordan**	**Wilsons**
Native Species Richness	5.94	5.59	6.15
Native Family Richness	9.61	9.86	8.21
Number of Individuals	10	10	10
Sensitive Species Richness	2.75	1.94	1.94
Percent Tolerant Individuals	6.31	7.76	7.59
Native Benthic Species	5.71	6.38	7.97
Water Column Species	5.94	4.16	4.16
Long-Lived Species	10	6.96	8.12
Percent Introduced Species	10	10	9.97
Percent Carnivores (individuals)	10	7	6.81
Percent Invertivores (individuals)	7.39	2.33	4.1
Percent Omnivores and Herbivores	10	4.03	4.55
IBI Score	**78.04%**	**63.34%**	**66.31%**

Table 5. Fish Index of Biotic Integrity (IBI) Scores from Spring 2006

Spring 2006 IBI Metrics			
Metric	**Galloway**	**Jordan**	**Wilsons**
Native Species Richness	8.4	5.3	6.4
Native Family Richness	10	9.41	10
Number of Individuals	10	10	8.6
Sensitive Species Richness	5.2	1.7	1.5
Percent Tolerant Individuals	9	7.6	7.7
Native Benthic Species	7.4	7.5	8.3
Water Column Species	9.4	2.5	3.3
Long-Lived Species	10	7.5	8.6
Percent Introduced Species	10	10	9.6
Percent Carnivores (individuals)	9.9	10	8.5
Percent Invertivores (individuals)	7.2	2.4	2
Percent Omnivores and Herbivores	5.9	4.4	4.2
IBI Score	**85.33%**	**65.26%**	**65.58%**

Table 6. Benthic Macroinvertebrate Taxa Collected in Galloway Creek 9/20/2005

9/20/2005 Galloway Creek Macroinvertebrate Taxa

Order	Class	Family	Genus/Species	Total	*BIV
Coleoptera		Elmidae	Stenelmis larvae	256	5.4
		Elmidae	Stenelmis adult	5	5.4
		Psephenidae	Psephenus	201	2.5
Odonata	Zygoptera	Coenagrionidae	Argia	6	8.7
Tricoptera		Hydropsychidae	Cheumatopsyche	5	6.6
Hemiptera		Veliidae	Microvelia	3	6.4
Ephemeroptera		Heptageniidae	Stenacron	5	7.1
		Baetidae	Fallceon	7	6
		Baetidae	Paracleodes	2	5
Decapoda		Orconectes		30	2.7
Isopoda				5	7.9
Molluska		Corbicula		1	6.3
Platyhelminthes	Tricladida	Planariidae		1	7.5
Diptera	Chironomids			35	8
Amphipoda				46	7.6
Annelida	Oligocheata			121	9.2
	Hirundinea			2	7.4

***Biotic Index Value** **Total Individuals** **731**

Table 7. Benthic Macroinvertebrate Taxa Collected in Jordan Creek 9/29/2005

9/29/2005 Jordan Creek Macroinvertebrate Taxa

Order	Class	Family	Genus/Species	Total	*BIV
Odonata	Zygoptera	Calopterygidae	Calopteryx	24	8.3
	Zygoptera	Coenagrionidae	Argia	2	8.7
	Zygoptera	Coenagrionidae	Enallagma	13	9
Ephemeroptera		Heptageniidae	Stenonema	11	3.4
		Caenidae	Caenis	17	7.6
		Baetidae	Fallceon	1	6
Decapoda		Orconectes		7	2.7
Diptera	Chironomids			13	8
Amphipoda				5	7.6
Annelida	Oligocheata			22	9.2
	Hirundinea			3	7.4
***Biotic Index Value**			**Total**	**118**	

Table 8. Benthic Macroinvertebrate Taxa Collected in Wilsons Creek 9/29/2005

9/29/2005 Wilsons Creek Macroinvertebrate Taxa

Order	Class	Family	Genus/Species	Total	*BIV
Coleoptera		Elmidae	Stenelmis	6	5.4
		Hydorphilidae	Tropisternus	1	9.8
Odonata	Zygoptera	Colopterygidae	Calopteryx	5	8.3
	Zygoptera	Coenagrionidae	Argia	2	8.7
	Zygoptera	Coenagrionidae	Enallagma	4	9
Ephemeroptera		Heptageniidae	Stenonema	20	3.4
		Caenidae	Caenis	16	7.6
		Baetidae	Fallceon	9	6
Decapoda		Orconectes		5	2.7
Platyhelminthes	Tricladida	Planariidae		1	7.5
Diptera	Chironomids			14	8
Amphipoda				40	7.6
Annelida	Oligochaeta			14	9.2
	Hirundinea			1	7.4
			Total	**138**	

Table 9. Benthic Macroinvertebrate Taxa Collected in Galloway Creek 2/13/2006

2/13/2006 Galloway Creek Macroinvertebrate Taxa

Order	Class	Family	Genus/Species	Total	BIV
Ephemeroptera		Caenidae	Caenis	2	7.6
		Heptageniidae	Stenonema	194	3.4
		Baetidae	Fallceon	83	6.0
Diptera		Simuliidae		11	6.0
		Chironomidae		328	8
Coleoptera		Elmidae	Stenelmis	46	5.4
		Psephenidae	Psephenus	33	2.5
Amphipoda		Gammaridae	Gammarus	32	6.9
		Hyalellidae	Hyalella azteca	27	7.9
		Crangonyctidae	Allocrangonyx	57	8.0
Annelida	Oligocheata			33	9.2
Trichoptera		Philopotamidae	Chimarra	79	2.8
		Hydropsychidae	Cheumatopsyche	57	6.6
		Rhyacophilidae	Rhyacophilia	1	0.8
		Polycentropdidae	Polycentropus	4	6
Molluska		Cobicula		2	6.3
Decapoda		Orconectes		1	2.7
			Total Individuals	**990**	

Table 10. Benthic Macroinvertebrate Taxa Collected in Jordan Creek 3/17/2006

3/17/06 Jordan Creek Macroinvertebrate Taxa

Order	Class	Family	Genus/Species	Total	BIV
Coleoptera		Elmidae	Stenelmis	1	5.4
Ephemeroptera		Caenidae	Caenis	5	7.6
		Heptageniidae	Stenonema	5	3.4
Diptera		Chironomidae		101	8
Odonata	Zygoptera	Calopterygidae	Calopteryx	1	8.3
Amphipoda		Hyalellidae	Hyallella azteca	3	7.9
Annelida	Oligocheata			7	9.2
			Total	**123**	

Table 11. Benthic Macroinvertebrate Taxa Collected in Wilsons Creek 3/17/2006

3/17/06 Wilson's Creek Macroinvertebrate Taxa					
Order	**Class**	**Family**	**Genus/Species**	**Total**	**BIV**
Ephemeroptera		Caenidae	Caenis	14	7.6
		Heptageniidae	Stenonema	23	3.4
Coleoptera		Elmdae	Stenelmis	4	5.4
		Psephenidae	Psephenus	1	2.5
Diptera		Chironomidae		117	8
Amphipoda		Hyalellidae	Hyalella azteca	17	7.9
Gastropoda		Ancylidae		1	7.1
			Total	**177**	

Table 12. Summary of Primary Metrics for Benthic Macroinvertebrate Data

Location	**Date**	**Taxa Richness**	**EPT Index**	**Biotic Index**	**Shannon Diversity Index**
Galloway	9/20/2005	14	3	6.912	2.179
Galloway	2/13/2006	17	7	6.086	2.114
Jordan	9/29/2005	11	3	7.557	2.237
Jordan	3/17/2006	7	2	7.843	0.754
Wilson's	9/29/2005	14	3	6.912	2.179
Wilson's	3/17/2006	7	2	7.266	1.108

Table 13. Summary of Macroinvertebrate Stream Condition Index Scores

Location	**Date**	**Score**	**Interpretation**
Galloway	9/20/2005	40%	Non-supporting
Galloway	2/13/2006	40%	Non-supporting
Jordan	9/29/2005	30%	Non-supporting
Jordan	3/17/2006	20%	Non-supporting
Wilson's	9/29/2005	40%	Non-supporting
Wilson's	3/17/2006	20%	Non-supporting

Table 14. Summary of Physical Habitat Data for Sample Site Transects (Data are summarized from the Channel/Riparian Cross-Section & Thalweg Profile Form completed at each site.)

	Galloway	Jordan	Wilsons
MEAN STREAM WIDTH (m)			
Bankfull	9.1	18.1	15.2
Wetted	4.8	5.8	10.8
MEAN STREAM DEPTH	25.4	33.9	35.7
THALWEG DEPTH (cm)			
Mean	32	54	61
Maximum	80	109	120
MEAN BANK HEIGHT (m)			
Incised	1.63	NA	2.93
Bankfull	2.67	NA	3.64
CHANNEL MAKEUP			
Percent Riffle	22	7	4
Percent Run	54	54	36
Percent Pool	24	39	60
SUBSTRATE			
Percent Silt-Sand	5.5	0	12.7
Percent Gravel	81.8	89.1	69.1
Percent Cobble-Boulder	7.3	0	9.1
Percent Bedrock	5.5	10.9	9.1
PERCENT FISH COVER			
Filamentous Algae	26.8	0	9.5
Macrophytes	0	0	0
Large Woody Debris	0	0.5	2.0
Brush	5.9	5.5	4.5
Overhanging Vegetation	3.2	17.3	10
Undercut Banks	3.2	35.0	7.5
Boulders	2.7	0	4.5
Artificial Structure	4.5	0	2.5
TOTAL COVER	46.4	58.2	36.8
TOTAL NON-ALGAE COVER	19.5	58.2	28.2